OPERATIONS MANUAL
FLT CREW TRAINING

PROJECT OPENSKY
B777

TAXI, TAKEOFF, CLIMB, CRUISE, DESCENT & LANDING

Photo and scheme by C. Vincent Cho

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project open sky
high quality freeware aircraft for microsoft flight simulator

<u>Disclaimer</u>
This manual is not provided from, endorsed by, or affiliated with The Boeing Company, United Air Lines, Inc., All Nippon Airways Company, Ltd., or any other airline in any way.

Any exact similarities between this manual and Project Opensky aircraft to actually aircraft, procedures, or airline carriers are strictly coincidental.

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The procedures contained within are this author's interpretation of generic flight operations. These procedures are not always accurate in all situations.

All diagrams have been recreated to mimic actual procedures or scenarios, however, are not taken from actual materials whatsoever.

This manual is not intended for real world flight.

In short, I've spent 6 months and painstaking attention to detail to give the flight simulator community the closest possible experience to flying the real 777 aircraft.

Project Opensky aircraft are intended as a freeware add-on for Microsoft Flight Simulator 2000.

Photo and scheme by C. Vincent Cho

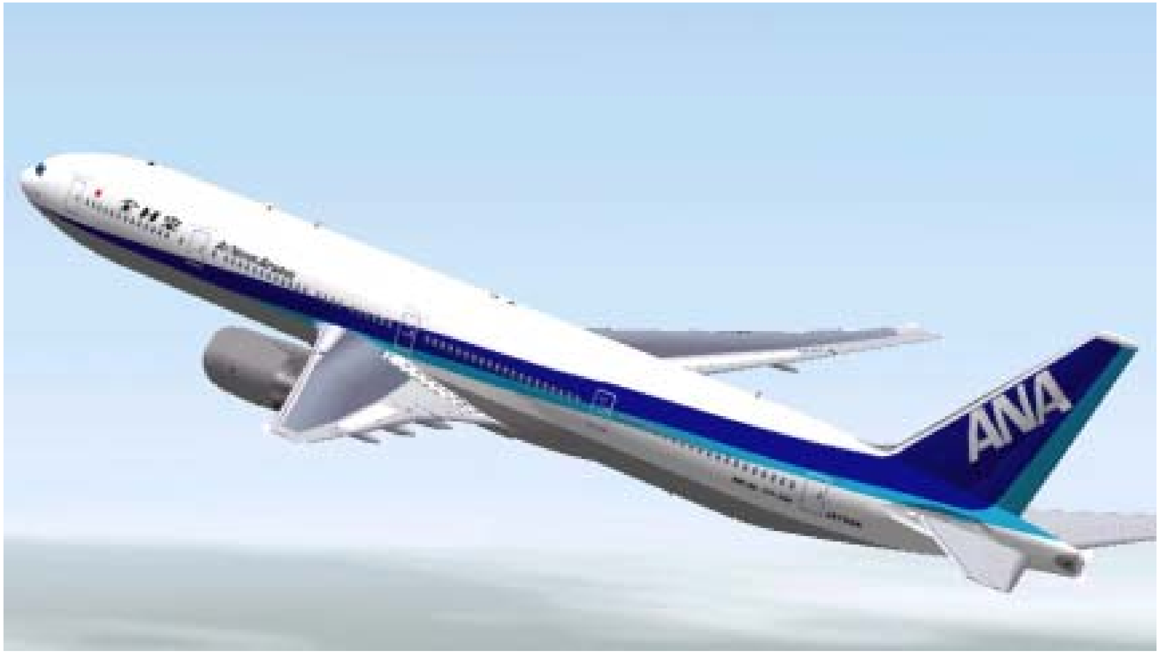

Photo and scheme by Yosuke Abe

Project Opensky Boeing 777-200, -200ER, 777-300 Series
Version 2.5

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Project Opensky Members

Flight model based on the most realistic data for the Boeing 777-200ER, Boeing 777-300, actual experiences on 777 flight decks, and several friends who will remain anonymous.

PREFACE

This manual serves as a reference for operating procedures and training maneuvers. The flight profiles show the basic recommended configuration during flight.

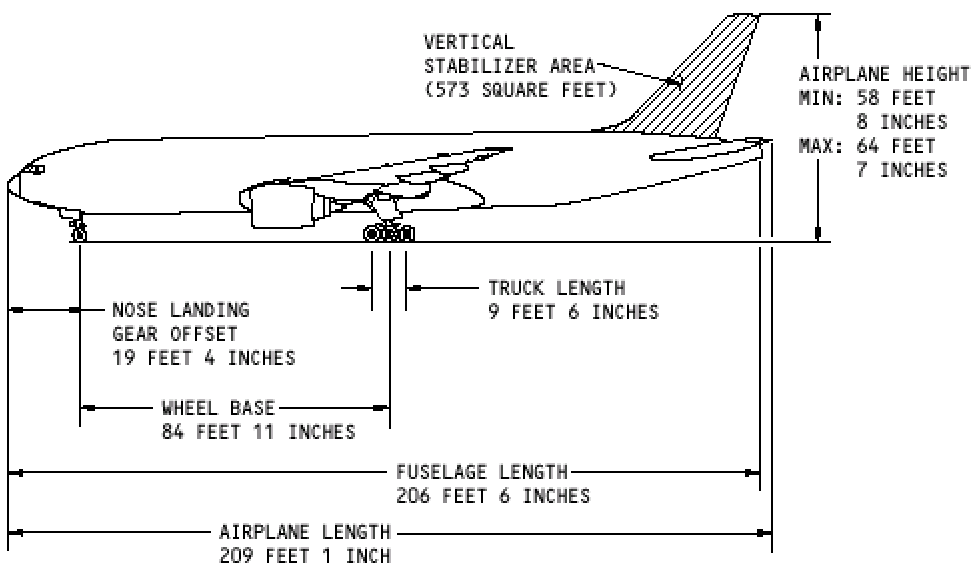
The maneuvers should normally be accomplished as illustrated. However, due to airport traffic, ATC distance separation requirements, and radar vectoring, modifications may be necessary.

Exercise good judgment.

PRINCIPLE DIMENSION AND AREAS

Boeing 777-200 – Aircraft Reference Manual

Flight Simulator 2000 Professional Edition



Boeing 777-200 (cont'd)

1) Height:
   Minimum -- 58 ft and 8 in
   Maximum -- 64 ft and 7 in

2) Length -- 209 ft and 1 in

3) Width -- 199 ft and 11 in

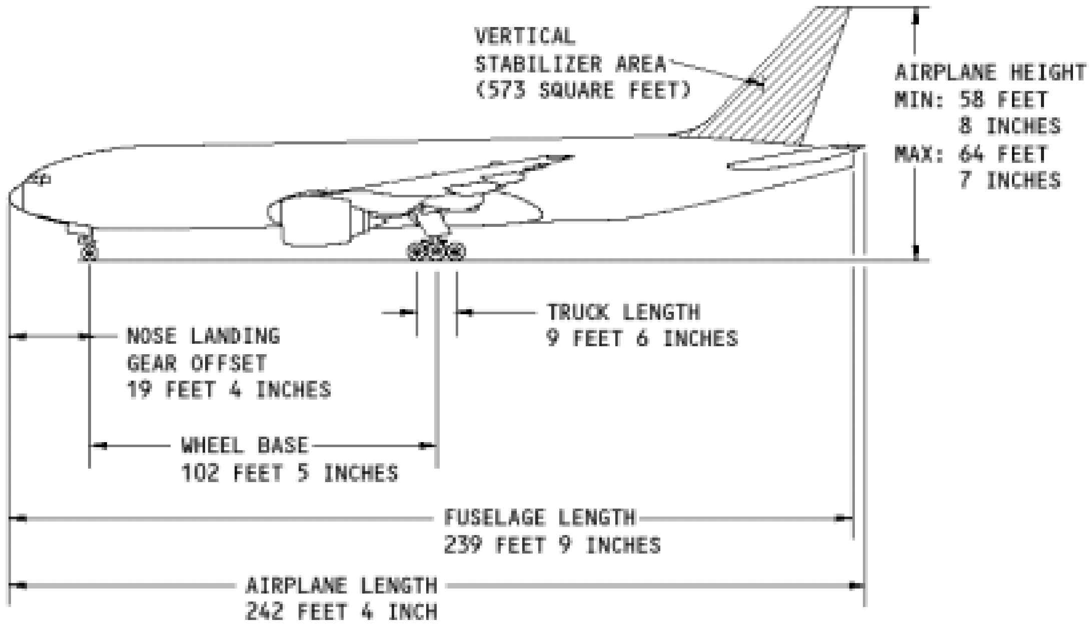
4) Engine to Ground Distance:
   Minimum -- 2 ft and 9 in
   Maximum -- 3 ft and 11 in

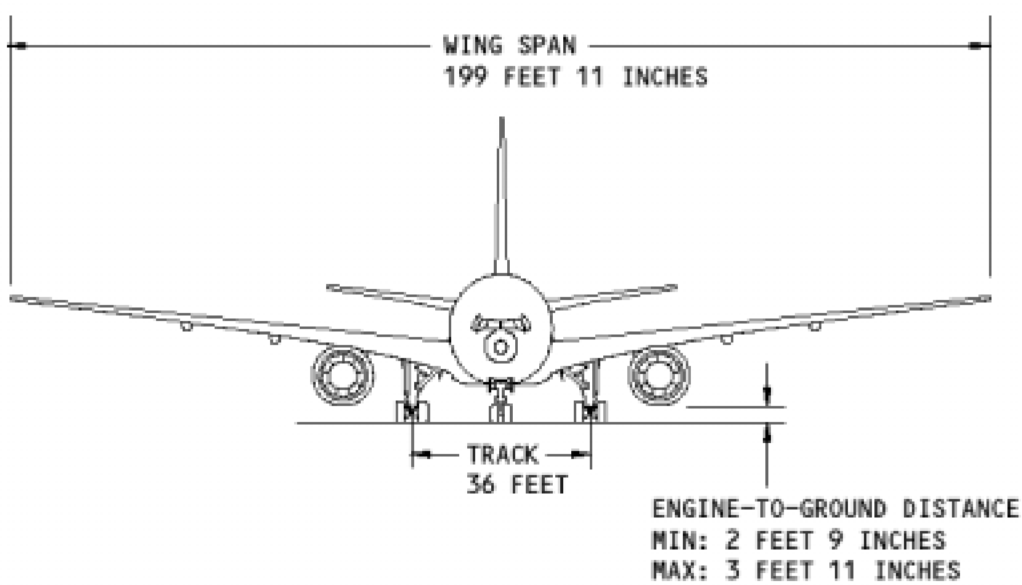
5) Fuselage to Engine Distance: (fuselage centerline to engine centerline
   31 ft and 5 in (376.67 in)

6) Fuselage Body Height Reference Plane @ Main Landing Gear:
   Minimum -- 16 ft and 6 in (198.33 in)
   Maximum -- 18 ft and 4 in (220.15 in)

7) Height (constant cross section):
   Above Body Reference Plane -- 11 ft and 11 in (142.7 in)

8) Landing Gear:
   Length -- 9 ft 6 in (114 in)
   Track -- 36 ft
   Nose Gear Offset -- 19 ft and 4 in
   Wheelbase -- 84 ft and 11 in


VERTICAL
STABILIZER AREA
(573 SQUARE FEET)
AIRPLANE HEIGHT
MIN: 58 FEET
8 INCHES
MAX: 64 FEET
7 INCHES
TRUCK LENGTH
9 FEET 6 INCHES
NOSE LANDING
GEAR OFFSET
19 FEET 4 INCHES
WHEEL BASE
102 FEET 5 INCHES
FUSELAGE LENGTH
239 FEET 9 INCHES
AIRPLANE LENGTH
242 FEET 4 INCH


WING SPAN
199 FEET 11 INCHES
TRACK
36 FEET
ENGINE-TO-GROUND DISTANCE
MIN: 2 FEET 9 INCHES
MAX: 3 FEET 11 INCHES

Boeing 777-300 (cont'd)

1) Height:
   Minimum -- 58 ft and 8 in
   Maximum -- 64 ft and 7 in

2) Length -- 242 ft and 4 in

3) Width -- 199 ft and 11 in

4) Engine to Ground Distance:
   Minimum -- 2 ft and 9 in
   Maximum -- 3 ft and 11 in

5) Fuselage to Engine Distance: (fuselage centerline to engine centerline
   31 ft and 5 in (376.67 in)

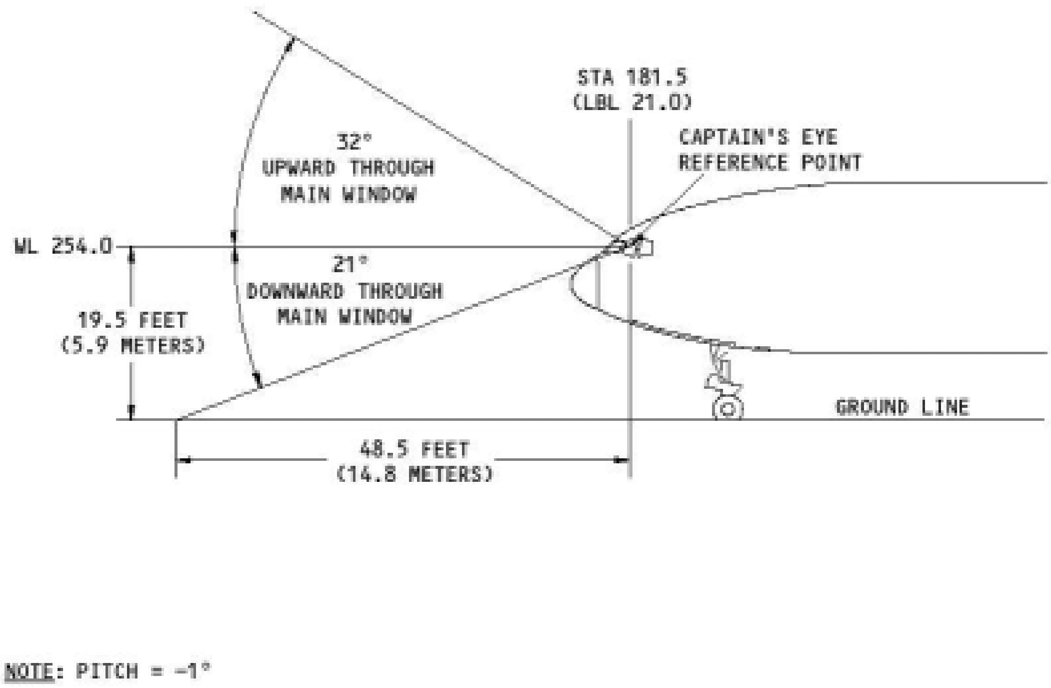
6) Fuselage Body Height Reference Plane @ Main Landing Gear:
   Minimum -- 16 ft and 6 in (198.33 in)
   Maximum -- 18 ft and 4 in (220.15 in)

7) Height (constant cross section):
   Above Body Reference Plane -- 11 ft and 11 in (142.7 in)

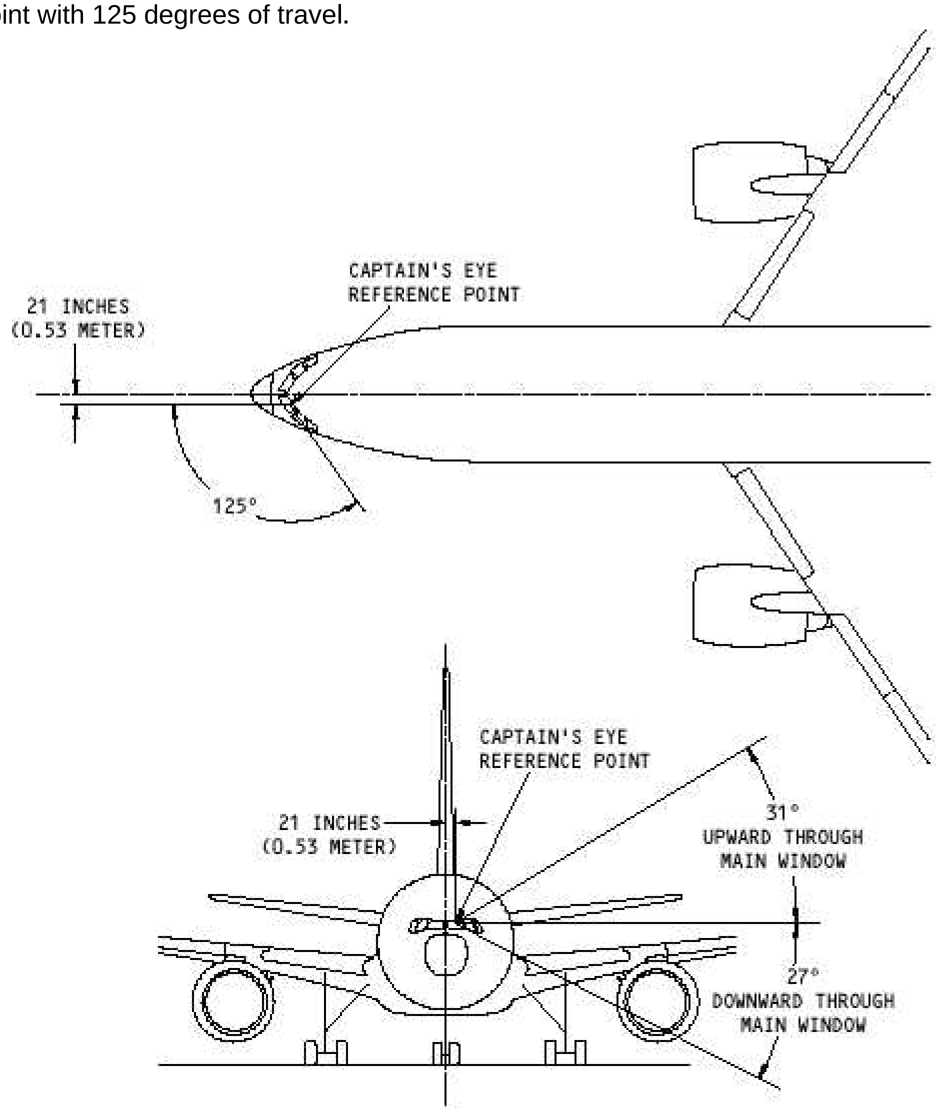
8) Landing Gear:
   Length -- 9 ft 6 in (114 in)
   Track -- 36 ft
   Nose Gear Offset -- 19 ft and 4 in
   Wheelbase -- 102 ft and 5 in

BASIC PILOT INFORMATION

Pilot's view reference point is approximately 19.5 feet from the ground, with ground visibility limited to 48.5 feet looking down at an angle of 21 degrees:



For proper engine and aircraft operations, the captain must view the EICAS as the engines and wings **are not** visible from the flight deck. Pilot's rearward view is based on the captain's eye reference point with 125 degrees of travel.



NOTE: HEAD ROTATED ABOUT POINT 3.3 INCHES (0.08 METER) AFT OF CAPTAIN"S EYE REFERENCE POSITION

TAXI

1) The nose wheel steering and the engine thrust are used to taxi the airplane.

2) Make sure you have the necessary clearance when you go near a parked airplane or other structures.

3) When the APU in the taxi airplane or the parked airplane is on you must have a minimum clearance of 50 feet between the APU exhaust port and the adjacent airplane's wingtip (fuel vent).

4) The taxi speed must not be more than approximately 30 knots. Speeds more than 30 knots added to long taxi distances would cause heat to collect in the tires. Recommended speed is 20 knots. Beware of changing GS numbers due to tailwinds during taxi.

5) Before making a turn, decrease the speed of the airplane to a speed of approximately 8 to 12 knots. Make all turns at a slow taxi speed to prevent tire skids.

6) Do not try to turn the airplane until it has started to move.

7) Make sure you know the taxi turning radius.

8) Monitor the wingtips and the horizontal stabilizer carefully for clearance with buildings, equipment, and other airplanes.

9) When a left or right engine is used to help make a turn, use only the minimum power possible.

10) Do not let the airplane stop during a turn.

11) Do not use the brakes to help during a turn. When you use the brakes during a turn, they will cause the main and nose landing gear tires to wear.

12) When it is possible, complete the taxi in a straight-line roll for a minimum of 10 feet.
NOTE: This will remove the torsional stresses in the landing gear components, and in the tires.

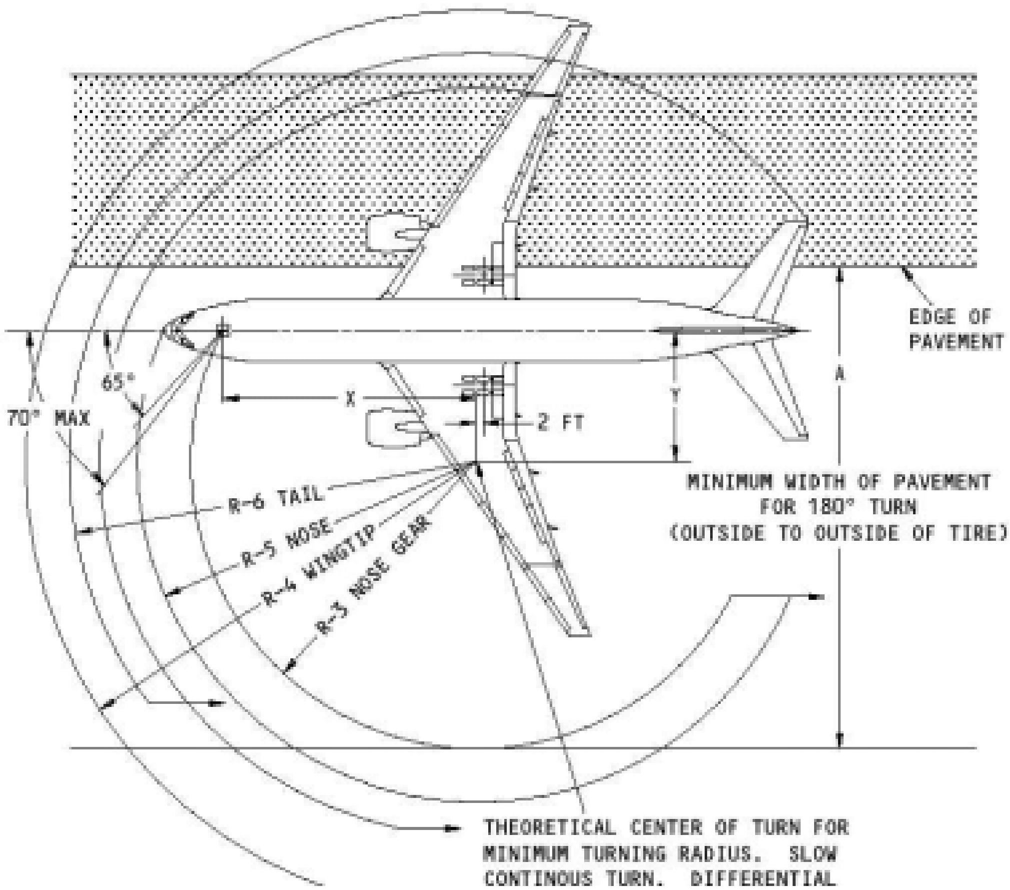
13) Use the Inertial Reference System (IRS) in the ground speed (GS) mode to monitor the taxi speed.

14) If the airplane taxi speed is too fast (with the engines at idle), operate the brakes slowly and smoothly for a short time. NOTE: This will decrease the taxi speed.

15) If the taxi speed increases again, operate the brakes as you did in the step before.

16) Always use the largest radius possible when you turn the airplane. NOTE: This will decrease the side loads on the landing gear, and the tire wear will be decreased.

17) Extra care must be given to turn the aircraft due to the fuselage length and wingspan. A minimum distance from the edge of the pavement must be maintained to reverse the aircraft's direction:



18) Operate the brakes to stop the airplane.

19) Set the parking brake after the airplane has stopped.

TAKEOFF

1) Align aircraft with runway centerline.

2) Increase power to approximately 50% N1 for 5 – 10 seconds.

3) Watch EICAS indicator for engine problems or aircraft alarms.

4) Increase power smoothly to pre-determined N1 speeds based on aircraft takeoff weight, (85% - 105% N1). This can either be done manually or using the autothrottle with the autopilot engaged.

5) At Vr, rotate aircraft 10 degrees upwards.

6) Hold nose at +10 degrees until positive rate of climb is confirmed, then raise landing gear after V2.

7) Set initial climbout speed to V2+15 KTS.

8) Maintain +15 degrees climb to 1500 FT. +10 degrees climb after 1500 FT.

9) At 1500 FT, begin slate retraction. Maximum slate speed limits are:

Slat Position	Max Speed
1	240
5	220
15	200
20	190
25	180
30	170

10) Increase speed to 230 – 250 in accordance with ATC instructions (max 250 KTS below 10,000 FT).

11) For full maneuverability beneath 10,000 FT, slates must be fully retracted with aircraft at minimum safe airspeed.

CLIMB

1) Once climb thrust or airspeed is set, the autopilot will compensate for environmental condition changes automatically during the climb.

2) It is recommended that the aircraft be flown manually up to 15,000 FT, weather and ATC traffic conditions permitting. However, in high traffic conditions, to easy the workload of the pilot, the autopilot MCP altitude intervention may be engaged above a minimum altitude of 80 FT with the landing gear up.

3) Climb settings use a 10 – 20% derate of thrust up to 10,000 FT, then increases linearly to max thrust at 30,000 FT.

4) For **enroute climb**, climb at a rate of 1800 - 3000 FPM, pursuant to ATC and traffic conditions. If there is no altitude or airspeed restrictions, accelerate to the recommended speed. The sooner the aircraft can be accelerated to the proper climb speed, the more fuel and time efficient the flight.

5) As **engine and wing icing** may occur during the climb and descent, the engine anti-icing system should be in the AUTO or ON position whenever icing is possible. NOTE: Failure to do so may result in engine stall, overheating, or engine damage.

6) **For normal economy climb**, follow ATC speed restrictions of 250 KTS below 10,000 FT. If permitted by ATC and no speed restriction below 10,000 FT, increase speed to 280 KTS. Above 10,000 FT, climb at 310 KTS or .84 MACH. Climb speed table is as follows:

ALTITUDE	**SPEED**
Sea Level to 10,000 FT	250 KTS
Above 10,000 FT	310 KTS/.84 MACH

7) **Max climb speed** is 310 knots until reaching .84 MACH at initial cruise altitude.

8) **For engine out climb**, speed and performance various with gross weight and altitude, however 280 knots at 1000 – 1500 FPM may be used.

9) Set **standard barometer** above airport transition level (depends on local airport geography).

CRUISE

1) **Cruise** at .84 MACH.

2) **Headwinds** will increase engine power, reduce cruise speed and decrease range.

3) **Tailwinds** will decrease engine power, increase cruise speed and increase range.

4) Follow previously entered FMC waypoints.

5) **Fuel Freeze --** Extended operation at cruise altitude will lower fuel temperature. Fuel cools at a rate of 3 degrees C per hour, with a max of 12 degrees C in extreme conditions. Fuel temperatures tend to follow TAT (total air temperature). To raise fuel temperature/TAT, a combination of factors can be employed:

   - Descend into warmer air.
   - Deviate to warmer air.
   - Increase Mach speed.

   An increase of 0.01 MACH will increase TAT by 0.5 – 0.7 degrees C.

6) **Increased fuel burn** can result from:
   - High TAT
   - Lower cruiser altitude than originally planned.
   - More than 2,000 FT above the optimum calculated altitude.
   - Speed faster or slower than .84 MACH cruise.
   - Strong headwind.
   - Unbalanced fuel.
   - Improper aircraft trim.

7) **Fuel penalties** are:

- 2000 FT above optimum – 3 percent increase in fuel usage
- 4000 FT below optimum – 5 percent increase in fuel usage
- 8000 FT below optimum –12 percent increase in fuel usage
- M.01 above M.84 – 3 percent increase in fuel usage
- Higher climb rates, 3000 fpm over 29,000 – increased fuel usage

8) In the case of **engine out cruise**, it may be necessary to descend. NOTE: For 777 **ETOPS (Extended Twin-engine Operations)** limitations, divert to the nearest available airfield within **207 minutes** (3 hr, 27 min) to avoid overstressing engines and unnecessary risk. Use good judgement to select an airfield that can accommodate an aircraft of this size. Consideration must also be giving to ground facilities to accommodate number of passengers on board.

9) Trim aircraft for proper elevator alignment.

10) In case of engine out cruise, trim rudder for directional alignment.

11) Deviate from flight plan for weather, turbulence, or traffic as necessary after receiving clearance from ATC.

DESCENT

1) Descent at pre-determined TOD (Top of Decent)

2) Descend at 310 KT above 10,000 FT.

3) Use speedbrakes or thrust to minimize vertical path error.

4) Proper descent planning is necessary to ensure proper speed and altitude at the arrival point. Distance required for descent is 3NM/1000FT. Descent rates are as follows:

Intended Speed	**Decent Rate**	
	CLEAN	WITH SPEEDBRAKES
.84 MACH/310 KTS	2300 FPM	5500 FPM
250 KTS	1400 FPM	3500 FPM
VREF 30 + 80 KTS	1100 FPM	2400 FPM

5) Plan to descend so that aircraft is at approximately 10,000 FT above ground level, 250 KTS, 30 miles from airport.

6) At average gross weights, it requires 60 seconds and 7 NMs to decelerate from 310 KTS to 250 KTS for level flight without use of the speedbrakes. It requires 115 seconds to slow from 310 KTS to minimum clean airspeed. Using speedbrakes will reduce the times and distances by half.

7) Arm speedbrakes and autobraking to position 2 on initial descent.

8) Set airport altimeter below transition level.

9) Avoid using the landing gear for drag above 180-200 KTS to avoid damage to doors or passenger discomfort.

10) **Recommended approach planning**, ATC and airport rules permitting:

- 250 KTS below 10,000 FT, 30 miles from airport.
- 180-230 KTS, 23 miles from airport.
- 160 KTS, 16 – 17 miles from airport.
- VREF, 5 – 7 miles from airport.

11) **In case of rapid descend due to depressurization**, bring aircraft down to a safe altitude as smoothly as possible. Using the autopilot is recommended. Check for structural damage. Avoid high load maneuvering.

12) **Bank Angle Protection (BAP)** is initiated if the pilot turns the aircraft beyond 35 degrees of bank. Under normal circumstances, with the autopilot off, the pilot should not maneuver the aircraft greater than 25 – 30 degrees of bank. Autopilot bank angle is limited to 20 degrees. If a normal turn is made under 35 degrees (ex. 20 degrees), the aircraft will hold a 1G flight path and maintain that degree of bank (will hold 20 degrees). Pilot action will be required to level the aircraft's wings if the degree of bank is between 10 – 30 degrees. If the aircraft is turned 36 or more degrees of bank, the wings will level to 30 degrees or less.

13) **Stall recovery** can be accomplished by lowering the aircraft's nose and increasing power at once to gain airspeed. Beware of terrain. Accelerate to VREF 30 + 80 KTS. Do not retract gear until confirmed stall recovery and positive rate of climb. Keep nose at 5 degrees above the horizon or less.

14) If deployed, do not retract slates during the recovery, as it will result in altitude loss.

15) In the event of engine out approach, approach at VREF+5 @ flaps 20.

16) Under normal conditions land @ VREF.

17) The Project Opensky 777 is a CATII/III aircraft, meaning the aircraft is capable of landing on autopilot in conditions where visibility is down to 50ft AGL.

18) Land the aircraft.

19) Disengage (autopilot autothrottle will disengage) reverse thrust at 80 knots.

20) Disengage autobraking at 60 knots or as necessary.

21) Turn off onto high-speed taxiways at 30 knots or less.

22) Decelerate to 8 – 12 knots for 90 degree turns.

23) Taxi to gate.

Project Opensky Boeing 777 – Frequently Asked Questions

Q) Why can't I see the wings from the flight deck?

A) As with the real 777 and other large airliners, the viewpoint in the flight deck is limited to 125 degrees behind you. With the long fuselage, the engines and wings are so far behind you, it is impossible to see them. Watch the EICAS for engine performance and messages. You are the pilot, not a passenger. Your place is on the flight deck.

Q) When I taxi down the runway, the nose seems to bob up and down. Is this normal?

A) Absolutely. All aircraft have a degree of travel in their struts. For the 777, this equates to approximately 3 feet of suspension travel. As the ground is uneven, it is natural for the aircraft to move around on its own weight.

Q) It seems difficult for me to turn the airplane on the ground with the rudder. What am I doing wrong?

A) First of all, you do not taxi the airplane with the rudder. One changes direction by moving the tiller. As in the real aircraft, it does not take much effort to turn the tiller (imagine driving a 656,000 lbs. Cadillac with 1 finger). However, as this is a limitation of MS FS2000, and you must use the rudder, you must use only slight inputs to the rudder. Try only a maximum of 4 – 5 taps on the keyboard, or less than 1 cm movement on your rudder pedals. It just takes getting used to.

Q) I'm turning, but the airplane is going straight. What's wrong?

A) Make sure your speed is 12 knots or less **before** making a 90 degree turn. Otherwise, you'll just roll over the tires. For the tightest turning, turn at 5 knots, but don't let the aircraft stop. It will take a lot of energy to get moving again.

Q) Sometimes when I engage the parking brake, the nose gear may seem to sink into the ground. What's wrong?

A) This is actually a limitation in MS FS2000. The aircraft file allows for an amount of suspension travel and compression rates, but the visual model doesn't display expanding or contracting struts. Also, the flight dynamics engine will not allow the strut to expand while the aircraft is sitting still. Until MS addresses this, after stopping, simply release the parking brake to raise the nose slightly, then reengage the brake.

Q) The 777 is a long airplane, on takeoff, even though the nose gear is in the air, the main wheels seem to remain on the ground for a short time. Is this correct?

A) Yes, it is. As the aircraft passes Vr, you will rotate the nose upwards and hold it there at 10 degrees. Remember, the main gear is a long way behind you. As the wings "bite in" from more airspeed, you'll achieve positive rate of climb.

The amount of force required at Vr to lift the nose is in direct correlation to aircraft CG based on fuel, cargo & pax loading. These inputs correspond to a t/o stabilizer trim setting that is computed by the flight mgmt computers. Obviously, the lighter the nose, the less force is req'd to raise the nose. T/O's at different gross weights & cargo loading configurations generate different feel characteristics at Vr. An initial degree of force is required to get the nose moving, then stabilize or neutralize the rotation to achieve about 10 degrees pitch in a 2-3 second time frame. Then the a/c basically will fly itself off the runway (from a friend of mine).

Q) Should I flare the 777 on touchdown?

A) On the 777-300, because of the extreme length of the fuselage, Boeing recommends not flaring to avoid tailstrike. Normal landings can be made in the 777 @ -850 to –650 feet per minute, as the struts will absorb the impact. If you choose to flare, do not flare more than 3 degrees above horizon.

Q) When I land, the nose seems to stay in the air for a long time before coming down and contacting the pavement. Did I do something wrong?

A) Not at all. Aircraft are balanced about their center of gravity. The real 777 takes a bit of time for the main wheels and struts to settle, before the spoilers are deployed, and enough downward force causes enough loss of airspeed to bring the front wheel "crashing" down onto the tarmac. If you've ever flown in a 777 flight deck, you will notice that when the nose gear contacts the ground, it's actually quite violent. It's a function of aircraft weight and length. The nose will bob slightly as the nose gear strut contracts, expands, then settles.

Q) I've never flown an airplane in MSFS that reacts to the ground as the Project Opensky 777 does. In real-life, how does the 777 struts react to the ground?

A) Good question, I'm glad you asked. A lot happens when you take a 350,000 lbs. object and bounce it on the ground at 130 mph. See this good article from Air and Space Magazine:

http://www.airspacemag.com/ASM/Mag/Index/1998/FM/bgft.html

Q) Wow, you Project Opensky guys seem to know a lot about the 777. Have you ever been in the flight deck of one?

A) Yes, several times.

Q) Has the 777 flight dynamics engine been tested by real-world airline pilots? And if so, what do they say?

A) Yes, they have. They say it's right on the money.

Q) I'm ready to fly right now. What are the best freeware and payware panels and sounds available today?

A) New and exciting add-ons for FS2000 come out daily. I feel the best currently are:

Best Payware Panel:

Phoenix Simulation 777 Pro

http://www.phoenix-simulation.co.uk

Best all around panel with excellent functionality. Worth spending the money

Best Freeware Panels:

Vanessa Leightower's 777 panel

www.flightsim.com
(search for a77pnl.zip)

Best photorealistic look, although down on functionality.

Yannick Lavigne's 777 panel
www.flightsim.com
(search for b777af2.zip)

Excellent photorealistic look, best framerates, very good additional views.

Best Payware Sounds:

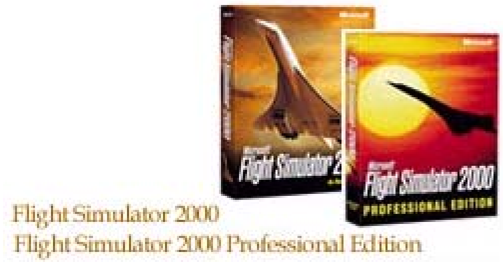
Phoenix Simulation 777 Pro

http://www.phoenix-simulation.co.uk

Very good all-around sound, especially on climbout.

Best Freeware Sounds:

Default Microsoft 777 sounds



Because you've already got it.
Good sound for default aircraft.

Q) What sound settings do you recommend?

A) Set your sound options for the engines to 1/8th maximum value. Decrease Navigation also to 1/8th bar. As for the other sounds, increase them all to 8/8th bar. In the 777, you are a long way away from the engines and the landing gear. You're separated from the cabin by the flight deck door, and the cabin is expansive.

For the most part, you mainly hear the hiss of pressurized air and the sounds of the flight deck. You practically don't hear the engines at all, except on takeoff, climbout, and when the thruster reverses engage. Other than that, the large PWs, RR Trents, or GE90s are quiet as a mouse.

Q) Will your Project Opensky 777 work with MS FS2002?

A) Yes.

Q) Will your Project Opensky 777 work with PSS's panel?

A) Yes, however, you may find if harder to see the runway. I feel that PSS's VREF numbers are about 5 – 10 knots too slow. On landing, either increase speed to VREF+5 or +10, or increase the ZFW entered into the FMC by 20,000 lbs.

Q) What type of flight-testing did Project Opensky perform on the 777 series?

A) Project Opensky Members have done extensive flight-testing with the 777. This author alone accumulated 316 hours of flight time in the 777 flight-test program. Project Opensky flight-testing is intense with many aircraft cycles. Tests included: engine out flight, in-flight engine restarts, engine out landings, CAT I/II/III landings, stall recovery, BAP, RTOs, minimum unstick tests, ETOPS, cold weather testing, 24 knot crosswind approaches with up to 38 knot gusts, and enroute flight testing of a maximum of 56 knot headwinds and 72 knot tailwinds. All weather was flown as downloaded from Microsoft real weather website.

Q) What other freeware add-ons to you recommend to increase realism?

A) **Enviro** to add ATC traffic and **FSUIPC** to raise wind levels above the default Microsoft level of 1000 FT. Both are available at Flightsim.com.

Q) When flying the Project Opensky 777, what will happen if I do not follow the procedures as they are listed in this manual?

A) You will crash. Project Opensky is not responsible for stupidity.

A LITTLE BIT ABOUT THE AUTHOR

My name is Warren and I travel around 100,000 miles a year. Most of my travels in recent years have been on the 777, which is now my favorite aircraft. I believe in the most realism possible.

I am not an airline captain, but love flight. Formally, I used to fly a Cessna 172 and a twin-engine Piper Cherokee. My goal is to give the flight simulator community the closest possible experience to flying a real 777.

My hobbies are flight, automobile track racing, and screenwriting.

I cannot promise I'll answer every single question, but someone at the forum will try to get an answer for you. Please send general comments to the forum at: www.project-opensky.com.

Remember that Project Opensky creates these aircraft for free, because we enjoy it. Do not bog us down with ignorant or unnecessary comments or criticism. If you feel you can do better, by all means, please do so, so that we may all benefit from everyone's hard work.